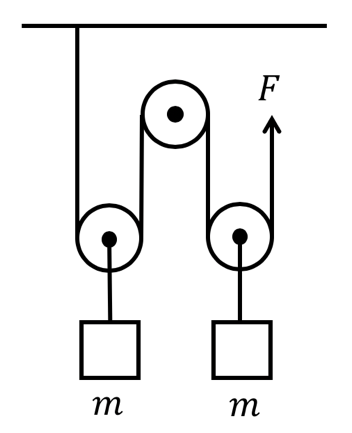
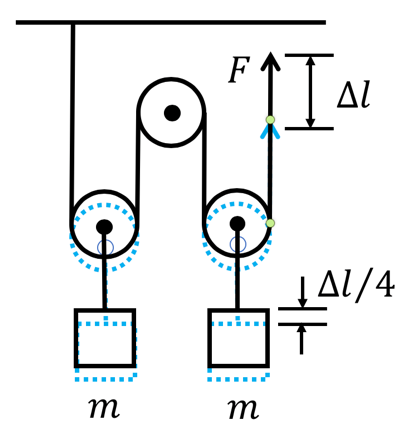
PHYS1110D – Engineering Physics: Mechanics and Thermodynamics

Tutorial Problems for Week 4: Newton’s Laws of Motion

**Problem 1 – Pulleys**

Two blocks with the same mass are hanging on two pulleys (see the figure). The pulley in the middle is fixed on a wall, while the other two can move freely. A force (upward) is applied to the rope so that the system is stationary. All the ropes are in vertical direction (except when they are winding around the pulleys). Ignoring all frictions and the mass of the pulleys:

1. If the end of the rope moves upward by a distance of , how will the two blocks move?
2. What is the magnitude of this force?

**Solution:**

1. The two blocks will move upward by (You can just feel it from the geometry – we don’t want to say too much here)
2. We use the energy argument again. We use the force to pull up the two blocks very slowly, so we need not consider the kinetic energy. The work done by the force is converted to the increase in the system potential energy. Therefore

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**Problem 2 – Normal Force**

A solid ball of mass is placed in a wedge formed by two planes as shown in the figure. Assuming no friction between the ball and the walls, find the magnitude and direction of both forces. ()

**Solution**:

The normal force is *always perpendicular to the contacting plane*.

Let the magnitude of the two forces be . Then we write down the equilibrium condition in the vertical and horizontal directions:

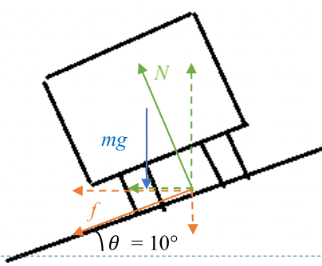
Therefore

*Remark*: You can benchmark your results by setting (then and ). In this case, the force exerted by the two walls should be very large. Such checking of answers prevents you from writing down things like (this will happen for some confused students).

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Description automatically generated**Problem 2 – Circular Motion on Banked Road**

A car is moving on a circular path on a highway. The distance between the car and the center of the circular path is 60 m (*ignoring the size of the car*). The road is banked at an angle of 10°. Given that the coefficient of static friction between the tires and the road surface is 1, find the range of the speed of the car such that it can move without slipping.

**Solution**:

The equation of motion along the radial and the vertical directions are (here we assume that the friction is pointing inwards; when it is in fact outwards, will be negative)

We first write solve for and as functions of :

You can check whether these results are reasonable (“benchmarking”) by setting : then

These are as expected. When the car does not slip, the range of should be